EVALUATION OF CORRELATION BETWEEN CEPHALOMETRIC CHARACTERISTICS AND TEMPOROMANDIBULAR JOINT DISORDERS: A RADIOGRAPHIC CROSS-SECTIONAL STUDY

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NAME OF THE GUIDE	Dr. Suman Jaishankar, M.D.S
HEAD OF THE DEPARTMENT	Dr. (Capt) S. Elangovan, M.D.S

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SCIENCE & RESEARCH.
TIRUCHENGODE - 637 215.

GUIDE

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Date : 18.01.19

Place : TIRUCHENGODE

Signature of the Head of the Department

Dr. (capt) S. Elangovan, M.D.S.,

PROFESSOR

PROFESSOR / HOD
DEPARTMENT OF ORAL MEDICINE
K.S.R. INSTITUTE OF DENTAL
SCIENCE & RESEARCH.
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Signature of the Guide

Dr. Suman Jaishankar, M.D.S.,

PROFESSOR

K.S.R INSTITUTE OF DENTAL SCIENCE AND RESEARCH

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Seal & signature of H.O.D

Dr. (Capt) S. ELANGOVAN, M.D.S.,

PROFESSOR

PROFESSOR / HOD
DEPARTMENT OF ORAL MEDICINE
K.S.R. INSTITUTE OF DENTAL
SCIENCE & RESEARCH.
TIRUCHENGODE - 637 215.

Seal & signature of Principal

PROF.Dr. G.S. KUMAR, M.D.S.,

PRINCIPAL

PRINCIPAL,
K.S.R. INSTITUTE OF DENTAL
SCIENCE & RESEARCH,
K.S.R. KALVI NAGAR,
THOKKAVADI POST,
TIRUCHENGODE - 637 215

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****

Dedicated to my father ***Mr.korath Kasu Ramachandran****, mother* ***Mrs. Mangaladevi Ramachandran****, my husband* ***Mr. Vishak baby*** *for their care, love, support and prayers to overcome all my hardships and being my constant source of support.*

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LIST OF GRAPHICAL PRESENTATIONS

ABBREVIATIONS

ANB	POINT A- NASION- POINT B ANGLE
Ar	ARTICULARE
Go	GONION
Go-Ar	GONION – ARTICULARE LINE LENGTH
LI	LOWER INCISOR
LI-MP	LOWER INCISOR- MANDIBULAR PLANE ANGLE
MP-SN	MANDIBULAR PLANE - SN ANGLE
N	NASION
POINT A	SUBSPINALE
POINT B	SUPRAMENTALE
S	SELLA
SNA	SELLA- NASION- POINT A ANGLE
SNB	SELLA-NASION- POINT B ANGLE
TMJ	TEMPOROMANDIBULAR JOINT
TMD	TEMPOROMANDIULAR JOINT DISORDERS
UI	UPPER INCISOR

Introduction

INTRODUCTION

The temporomandibular joint is described as one of the most complex joints in the body. It is a bilateral, diarthrodial, joint (TMJ). It has been considered a ginglymoarthrodial joint. The TMJ and its associated structures play an essential role in guiding mandibular motion and distributing stresses produced by everyday tasks such as chewing, swallowing, and speaking.[1]

Temporomandibular joint disorders (TMD) are used to describe a "group of orofacial conditions affecting temporomandibular joint and its associated structures". [2,3] The etiology of TMD is complex and multifactorial. Etiological factors include occlusal abnormalities, orthodontic treatment, para-functional habits and orthopedic instability, macrotrauma and microtrauma, joint laxity and exogenous estrogen.[4, 5]

The numerous factors that can contribute to this disorder are grouped into three categories. Predisposing factors will increase the risk of developing TMD, initiating factors will lead to the onset of the disease and perpetuating factors will either interfere with the healing process or enhance the progression of TMD. In some instances, a single factor may serve one or all of these roles.[6]

Initiating factors are primarily related to trauma or adverse loading of the masticatory system. Perpetuating factors may include the following:

- Behavioral factors (grinding, clenching and abnormal head posture)
- Social factors (affect perception and influence of learned response to pain)
- Emotional factors (depression and anxiety)
- Cognitive factors

`Predisposing factors are pathophysiological, psychological or structural processes that alter the masticatory system and lead to an increase in the risk of development of TMD.[6]

The most common signs and symptoms of TMDs are pain or tenderness in the temporomandibular joint, muscles of mastication, facial areas, ear region, shoulder and neck, hearing of clicking, popping or grating sound when opening / closing the mouth, while chewing or yawning, deviation of the mandible, limited mouth opening, locking of the joint, difficulty while chewing and sensation of an uncomfortable bite. [7, 8]

Diagnostic criteria for TMD which is reliable and valid, is needed to render easy diagnoses in both clinical and research settings. The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) has been the most widely employed diagnostic protocol for TMD research since its publication in 1992.[9,10]

Magnetic resonance imaging is considered as the best imaging modality for the evaluation of temporomandibular joint disorders (TMD. The major advantage of MRI is its ability to study the articular disc and its location, relative to the condyle in both closed- and open-mouth positions.[11]

Non-invasive modalities should first be explored, for patients seeking management of TMD symptoms. However, the complicated nature of the TMJ, along with the debilitating nature of late stage disease, has created a demand for more invasive solutions.[12]

The non-invasive modalities implemented most commonly include physical therapy, occlusal splints and/or adjustments, and pharmacologics.[13] Minimally invasive modalities for management of TMD symptoms include sodium hyaluronate and corticosteroid injections, arthrocentesis, and arthroscopy.[14] For the 5% of TMD patients whose nonsurgical methods fail, open joint surgery may be necessary to restore mandibular motion and mitigate orofacial pain.[15]

Lateral cephalographs assess accurately the extent to which a patient deviates from normal facial and dental morphologies.[16] A few reports show that the steep maxillary incisor angle and shorter posterior facial heights as strongly related to temporomandibular disorders.[17,18]

Lateral cephalographs are widely available and commonly taken in the dental practice for orthodontic purposes. If the predisposition to TMD can be assessed using lateral cephalometry, it should be routinely evaluated when taken. This can aid in initiating an early diagnosis of signs and symptoms of temporomandibular disorders. Hence, this study was designed to determine the cephalometric characteristics in TMD patients and compare it with normal subjects.

Aims and Objectives

AIMS AND OBJECTIVES

AIM:

To compare cephalometric characteristics in patients with temporomandibular joint disorders (TMD) and control group and determine the variation in angulation.

OBJECTIVE:

The objective of this study is to analyse if there is a difference in cephalometric features of patients with temporomandibular joint disorders (TMDs) when compared with normal patients and also assess the severity of the temporomandibular joint disorders in the study patients using a questionaire, and to compare the cephalometric angulations in the study patients based on severity.

Review of Literature

REVIEW OF LITERATURE

TEMPOROMANDIBULAR JOINT

Dorland (1957)[19] described that the temporomandibular joint is a ginglymoarthrodial joint, a term that is derived from ginglymus, meaning a hinge joint, allowing motion only backward and forward in one plane, and arthrodia, meaning a joint which permits gliding motion of the surfaces.

Gray et al (1994)[20] considered the the temporomandibular joint as a diarthrodial synovial paired joint which functions in pairs and the joint movement will involve both joint compartments.

Pertes RA and Gross SG (1995)[21] stated that the temporomandibular joint commonly called “TMJ” is an important joint that connects the mandible to the skull and regulates mandibular movement. It is one of the most complex joint in the body, performing multiple vital functions.

TEMPOROMANDIBULAR DISORDERS

J. B. Costen: (1934)[22] hypothesized that malocclusion caused TMD, and placed emphasis on ear symptoms, such as tinnitus, otaglia, impaired hearing, and even dizziness. This condition was initially known as "Costen's syndrome", eponymously referring to James B. Costen.

Schwartz LL (1955)[23] his colleagues were among the first to emphasize recognition that the masticatory muscles and not the TMJ were responsible for many of the signs and symptoms occurring in patients and the need to focus on more than the teeth. They also implicated psychological stress as a contributing etiologic factor.

Ramfjord and Ash s (1966)[24] stated occlusal disturbances in the aetiology of TMDs, or "Functional disturbances of the masticatory system"

Laskin DM (1969)[25] expanded the concepts of Schwartz and proposed a new theoretical system of etiology for the muscular disorder. He also suggested use of the term myofascial pain-dysfunction (MPD) syndrome for this condition in order to clearly distinguish it from the problems caused by intracapsular joint pathology. He proposed four "gold standard" diagnostic symptoms and signs of TMD which included facial or jaw pains, tenderness of the muscles of mastication, sounds that originate in the TMJ, often with jaw deviations and restricted jaw opening.

Laskin DM & Greenfield W (1982)[26] stated that the various conditions affecting the TMJ and the muscles of mastication should be distinctly separated diagnostically and therapeutically, and that they should be referred to collectively as temporomandibular disorders (TMDs) and not TMJ problems

Greene CS (1995)[27] explained that the etiology of TM disorders includes a multifactorial combination of physical and psychosocial factors, with some of them being either poorly understood or difficult to assess.

Egermark I et al (2003)[28] in a 20-year follow-up supports the opinion that no single occlusal factor is of major importance for the development of TMD. They suggested that a lateral forced bite between retruded contact position and intercuspal position , and a unilateral cross-bite, may be a potential risk factor in this respect.

Oral K et al 2009 [29] stated that trauma, occlusal discrepancies, stress, parafunctions, hypermobility, age, gender, and heredity have been implicated in the etiology of temporomandibular disorder pain.

Giannakopoulos NN 2010[30] believed that temporomandibular disorder contributes to a high proportion of socioeconomic costs, which are usually associated with comorbidities, such as depression and other psychological factors.

SIGNS AND SYMPTOMS OF TEMPOROMANDIBULAR DISORDERS

Feine and Lund (1977) [31] stated the symptoms of TMD as including pain, clicking or grinding sounds in the joint; dysfunction and limitation in mouth opening and other movements.

De Bover (1979) [32] described the signs and symptoms of TMD to be pain and tenderness in and around the TMJ and in the muscles of mastication, impaired mobility of the mandible, and presence of TMJ sounds.

Suvinen TI et al 2005 [33] regarded the clinical presentation of TMD, to manifest as pain. Pain can be present in ears, eyes, and/or throat, producing neck pain, facial pain, and headaches

Rutkiewicz T et al 2006[34] stated that 75 percent of adults show at least one sign of joint dysfunction on examination and as many as one third have at least one symptom.

Bevilaqua-Grossi D et al 2006[35] described that the pain frequency during mastication, temporomandibular joint (TMJ) pain, and TMJ sounds were shown to be good predictors of TMD severity. The signs and symptoms included neck pain, headache, difficulty during mouth opening and lateral deviation, and tenderness to palpation of masticatory sites and during protrusion.

Wright EF 2007[36] considered aural symptoms such as tinnitus, otalgia, dizziness or vertigo, sensation of otic fullness, hyperacusia or hypoacusia are thought to be associated with TMD

Wassell R et al 2008[37] described signs such as locking of the jaw, or stiffness in the jaw muscles and the joints, especially present upon waking.

Mujakperuo HR et al 2010[38] **noted** that pain in Temporomandibular disorders is usually aggravated by manipulation or function.

Stechman-Neto J 2016[39] reported that the most common TMD signs and symptoms are those related to muscle sensitivity through palpation, restricted mouth opening, asymmetric mandibular movements, joint sounds, muscle, and TMJ pain.

DIAGNOSTIC CRITERIA

Dworkin SF, LeResche L. 1992[40] reported that the launching of the research diagnostic criteria for temporomandibular disorders (RDC / TMD) by American Academy of Orofacial Pain (AAOP) aimed at improving the quality of research in the field.

Schiffman, Ohrbach R 2014[41] considered the most recent published version of this classification in 2014, named Diagnostic Criteria for TMD (DC/TMD), aimed to improve the sensibility and specificity of the previous RDC/TMD.

TREATMENT

Fricton JR 1995[42] Treatment is generally directed toward the restoration of a more physiological state in the muscles of mastication and involves medications, appliances, various forms of behavioural modification, and the use of muscle exercises as well as trigger point therapy.

Dimitroulis G et al 1995[43] conducted a study on forty- six patients with persistent closed lock of the TMJ of acute onset. They were treated by TMJ arthrocentesis and lavage with manipulation in an out-patient setting. Clinical data was gathered in the form of visual analogue scales for pain and chewing ability, and measurements were

taken of maximum mandibular opening before and after treatment. They concluded that TMJ arthrocentesis and lavage is recommended as a simple alterntive to more invasive TMJ procedures as an effective technique for the treatment of acute persistent closed lock of the TMJ.

Pinheiro et al. 1998[44] used LLLT with wavelengths of 632.8, 670, and 830 nm and an average dose of 1.8 J/cm^2 to treat 24 TMD patients. They found significant recovery from pain and clicking in the treated patients. Using a GA-As laser at 904 nm and a light dose of 3 J/cm^2.

Kulekcioglu S et al 2003[45] proposed that muscles with painful symptoms should be treated with the laser beam applied point wise with an ED of 3 J/cm^2 at three predetermined points on the masseter and temporal muscles.

Medlicott 2006 [46] explained conservative treatments for TMD include medication, physiotherapy, occlusal splints, self-management strategies, and interventions based on cognitive behavioral approaches.

Guo C et al 2009[47] in a systematic review reported a lack of evidence supporting the use of arthrocentesis or arthroscopy for TMD treatment.

Pramod G et al 2011[48] conducted a study on thirty-five patients who were recruited with a diagnosis of temporomandibular disorder based on standard clinical diagnostic criteria for temporomandibular disorder. The patients were divided in to one of the

following two groups: placebo or diazepam at random. Diazepam had shown better effects for chronic orofacial muscle pain .This study suggests that the placebo can give near similar results as diazepam can, so the role of placebo should also be considered as one of the important management strategies.

Machoň V et al 2012[49] stated that arthroscopic lysis and lavage of the TMJ is safe and beneficial in chronic anterior disc displacement without reduction. Patients with a shorter duration of symptoms benefited more compared to those with a longer duration.

Emara et al 2013[50] assessed the effects of BTX in the lateral pterygoid muscle as a treatment option in 11 joints. They observed that toxin injection eliminated the click sound in 10 joints during the first week and in one joint after one week.

Qvintus et al. 2015[51] Qvintus et al evaluated the long-term effects of splint therapy; after one year, 27.6% of TMD patients who received splint treatment and 37.5% of TMD patients who received counseling and instructions regarding masticatory muscle exercises, reported very good response to treatment.

Varoli FK et al 2015 [52] proposed that NSAID sodium diclofenac, both by itself and in combination with acetaminophen, carisoprodol, and caffeine, has been proven to have a more rapid positive effect on masticatory muscle pain compared with placebo.

Haviv Y et al 2015[53] stated that TCAs is used for myofascial masticatory chronic pain, particularly amitriptyline and nortriptyline, as first-line treatments with low doses of 10–35 mg per day.

Bijjaragi S et al 2015[54] conducted a study on 20 patients who received active TENS therapy and 20 who received placebo TENS therapy. Visual Analogue Scale (VAS) was used to measure the change in pain and tenderness in muscles of mastication and Temporomandibular joint, during and after TENS therapy along with mouth opening. Both the therapies were effective in reducing intensity of pain in TMDs, especially the active TENS therapy, in the musculoskeletal and chronic pain along with improvement in the range of mandibular movement and mouth opening.

Gewandter JS 2016[55] stated the most commonly used drugs in TMD include nonsteroidal anti-inflammatory drugs (NSAIDs), corticoids, analgesics, muscle relaxants, anxiolytics, opiates, tricyclic antidepressants (TCAs), gabapentin, and lidocaine patches.

Laskin DM 2018[56] mentioned the introduction of arthroscopy of the temporomandibular joint represented a major change in the management of internal derangements and to the realization that re-establishing joint mobility by arthroscopic lysis and lavage proved as effective as surgically restoring disc position. It was afterwards shown that such treatment could be done without joint visualization.

CEPHALOMETRIC ANALYSIS

Broadbent BH 1931[57] proposed the era of cephalometry, from the historical works that presented to the orthodontic community,and introduced the cephalostat, device that allows the placement of the patient's head always on the same position

Tenti FV 1981[58]stated that Cephalometric analysis is the clinical application of cephalometry. It is frequently used by dentists, orthodontists, and oral and maxillofacial surgeons as a tool for treatment planning. It is used as means of analysis of the dental and skeletal relationships of a human skull.

Krull JT et al 2016[59] reported the ultimate diagnostic value of the cephalometric analysis is dependent on the initial accurate identification and localization of anatomic and anthropologic points

CEPHALOMETRIC ANALYSIS IN TEMPEROMANDIBULAR DISORDERS

Ingervall B et al 1974 [60] demonstrated that TMD is significantly associated with posterior crossbite, anterior open bite, Angle Class III malocclusion, and extreme maxillary overjet.

Pullinger A 1987 [61] reported that patients with disk displacement with reduction have a more posterior condyle position than do normal subjects

Ronquillo HI et al 1988[62] suggested that patients with disk displacement with reduction have a more posterior condyle position than do symptomatic normal subjects or patients with disk displacement without reduction

Dibbets JM 1996[63] proposed that the adults with clicking joints had less deep faces than those without clicking in the sagittal plane. Adults with crepitating joints were characterized by less deep faces, plus a shorter pharynx (basion to PTM), anterior cranial base (S-N dimension), and posterior cranial base (sella to basion) dimension.

Ahn SJ et al 2006[64] proposed the subjects with TMJ Internal derangements had small SNB angles and Nasion perpendicular to pogonion, with large facial convexity and ANB angles. This means a skeletal Class II pattern with retrognathic mandible. The changes were more intensive as TMJ Internal Derangement progressed to a severe form. This study showed that progress of TMJ ID is strongly associated with changes in dentofacial morphology, particularly mandibular morphology

Bertram S et al 2012[65] considered changes in mandibular morphology such as decrease in ramus height and mandibular body length, and increase in gonial and articulare angle were described to become more severe as TMJ Internal derangement progressed to bilateral disk displacement without reduction

Almăşan OC et al 2013[66] stated angle Class II and III malocclusions, and large overjets have been associated with signs and symptoms of TMD. In this study,

overjet was statistically higher in subjects with temporomandibular disorders, independently of the sagittal skeletal pattern.

Chen S et al 2015[67] reported that the patients with class II deformity are prone to internal derangements and osteoarthrosis . It has been noted that the deformities are more severe in case of disk displacement without reduction compared to disk displacement with reduction.

Materials and Methods

MATERIALS AND METHODS

SOURCE OF DATA:

Patients visiting the department of Oral Medicine and Radiology at KSR Institute of Dental Sciences and Research, Tiruchengode, Namakkal district, Tamil Nadu.

METHOD OF COLLECTION OF DATA:

The study protocol was evaluated and approved by the institutional ethical review board. 40 symptomatic patients with TMD were included in the study after clinical examination was conducted and 40 asymptomatic, age and gender matched subjects referred for lateral cephalometric radiography intended for orthodontic purpose were taken as controls. Subjects were exposed to radiation after obtaining an informed consent and under optimal radiation protection principles. The patients with TMD were made to answer a questionnaire to assess the severity of their condition.

INCLUSION CRITERIA:

- Subjects in the age group of 18 to 40 years.
- Subjects with a chief complaint of pain, clicking/ crepitus or pain alone in the pre-tragal region with or without reduced mouth opening.

EXCLUSION CRITERIA:

- Patients with developmental disturbances of TMJ.
- Patients with a history of trauma to TMJ and ankyloses.
- Patients with severe debilitating diseases and pregnancy

METHODOLOGY:

Each subjects' history of presenting illness were carefully recorded and scrutinized to delineate the etiology for the symptoms and a thorough TMJ examination was done. A standard examination protocol was followed which included extra-auricular palpation, range of movements by measurement of unassisted and assisted mouth opening, right and left lateral movements, recording of any joint noises and finally, assessing any deviation or deflection on mouth opening and gauging midline deviation if any. The subjects with TMD were provided with 10 questions from Fonseca's anaemnestic questionnaire to assess the severity, based on their symptoms. The TMJ examination was followed by exposing the cases and controls to lateral cephalometric radiography. Patients with TMD were subjected to TMD tomography if necessary. All the images were be stored in DICOM format in the computer database. These lateral cephalographs were then analyzed digitally to compare the difference between the control group and TMD patients and evaluated via Steiner's analysis and Rakosi's analysis .

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A selected few lateral cephalometric parameters were measured:

- SNA, SNB and ANB angles to classify subjects into Class I, II, III.
- Mandibular plane to SN plane angle to assess if the subjects have a horizontal or vertical growth pattern.
- Upper incisor line to SN plane angle and lower incisor line to mandibular plane angle to assess the proclination of teeth.
- Gonion-articulare line length to assess the posterior facial height

QUESTIONNAIRE:

The patients with temporomandibular disorders were interviewed according to Fonseca's Anamnestic Questionnaire which consisted of 10 questions. Each question had yes, no and sometimes as options for the possible responses. The response to the questions were scored by assigning:

- 10 marks in cases where the response was yes
- 5 marks for sometimes
- And 0 marks for no.
- **According to clinical index classification based on Fonseca's questionnaire, patients who obtained a score between:**

- 0-15 were graded as TMD free
- 20-40 as having mild TMD
- 45-60 as having moderate TMD
- 70-100 as having severe TMD

FIGURE 1 - PALPATION OF TMJ

FIGURE 2- PALPATION OF TEMPORALIS MUSCLE

FIGURE 3 - PALPATION OF THE TENDON OF THE TEMPORALIS

FIGURE 4 - PALPATION OF MASSETER

FIGURE 5- PALPATION OF LATERAL PTERYGOID

FIGURE 6 - PALPATION OF MEDIAL PTERYGOID

FIGURE 7 : MEASUREMENT OF MOUTH OPENING

FIGURE 8: DIGITAL SYSTEM FOR LATERAL CEPHALOGRAM (SIRONA-ORTHOPHOS X G)

TABLE 1: LANDMARKS USED IN CEPHALOMETRIC EVALUATION

LAND MARK	LOCATION
SELLA (S)	• Midpoint of sella turcica
NASION (N)	• Most anterior point on frontonasal suture
A POINT (SUBSPINALE)	• Most concave point of anterior maxilla
B POINT (SUPRAMENTALE)	• Most concave point on mandibular symphysis
UPPER INCISOR (UI)	• A line connecting the incisal edge and root apex of the most prominent maxillary incisor
LOWER INCISOR (LI)	• A line connecting the incisal edge and root apex of the most prominent mandibular incisor
GONION (Go)	• Intersection of mandibular plane and ramus of mandible
ARTICULARE (Ar)	• Junction between inferior surface of the cranial base and the posterior border of the ascending rami of the mandible

TABLE 2: TABLE DEPICTING STEINER'S ANALYSIS

POINTS	NORMAL VALUE	INTERPRETATION
SELLA- NASION- POINT A ANGLE (SNA)	82 ± 2º	This angle indicates the horizontal position of the maxilla relative to the cranial base. • >85° - protrusive or prognathic maxilla • <79° - deficient or retrognathic maxilla
SELLA-NASION- POINT B ANGLE (SNB)	80 ± 2º	This angle expresses the horizontal position of the mandible relative to the cranial base. • >82° - prognathic mandible • <76° - retrognathic mandible
POINT A- NASION- POINT B ANGLE (ANB)	2 º ± 2º	The ANB angle measures the relative position of the maxilla to mandible. • >4° indicates a Class II skeletal jaw relationship, protrusive maxilla or retrognathic mandible. • <1° indicates a Class III skeletal jaw relationship, deficient maxilla or prognathic mandible.
MANDIBULAR PLANE - SN ANGLE (MP-SN)	32 º	Indicates the growth patterns of an individual. • >32 º Indicates vertical growth pattern • <32 º Indicates horizontal growth pattern

TABLE 3: TABLE DEPICTING RAKOSI'S ANALYSIS

POINTS	NORMAL VALUE	INTERPRETATION
UPPER INCISOR - SN PLANE ANGLE (UI-SN)	104°	This angular measurement determines the inclination of the central incisor relative to the anterior cranial base. • A greater than average angle indicates proclination. • A smaller than average angle indicates upright or retroclined (lingually inclined) incisors
LOWER INCISOR-MANDIBULAR PLANE ANGLE (LI-MP)	90°±5°	It defines the axial inclination between the mandibular incisor and the inferior border of the mandible. • The more the incisor is labially inclined, the greater the angle.
GONION – ARTICULARE LINE LENGTH (Go-Ar)	• Males : 52 ± 2mm • Females: 46.8 ± 2.5mm	Linear distance between articulare and gonion. • Variations in ramal length can be a causative factor for skeletal open bite or deep bite

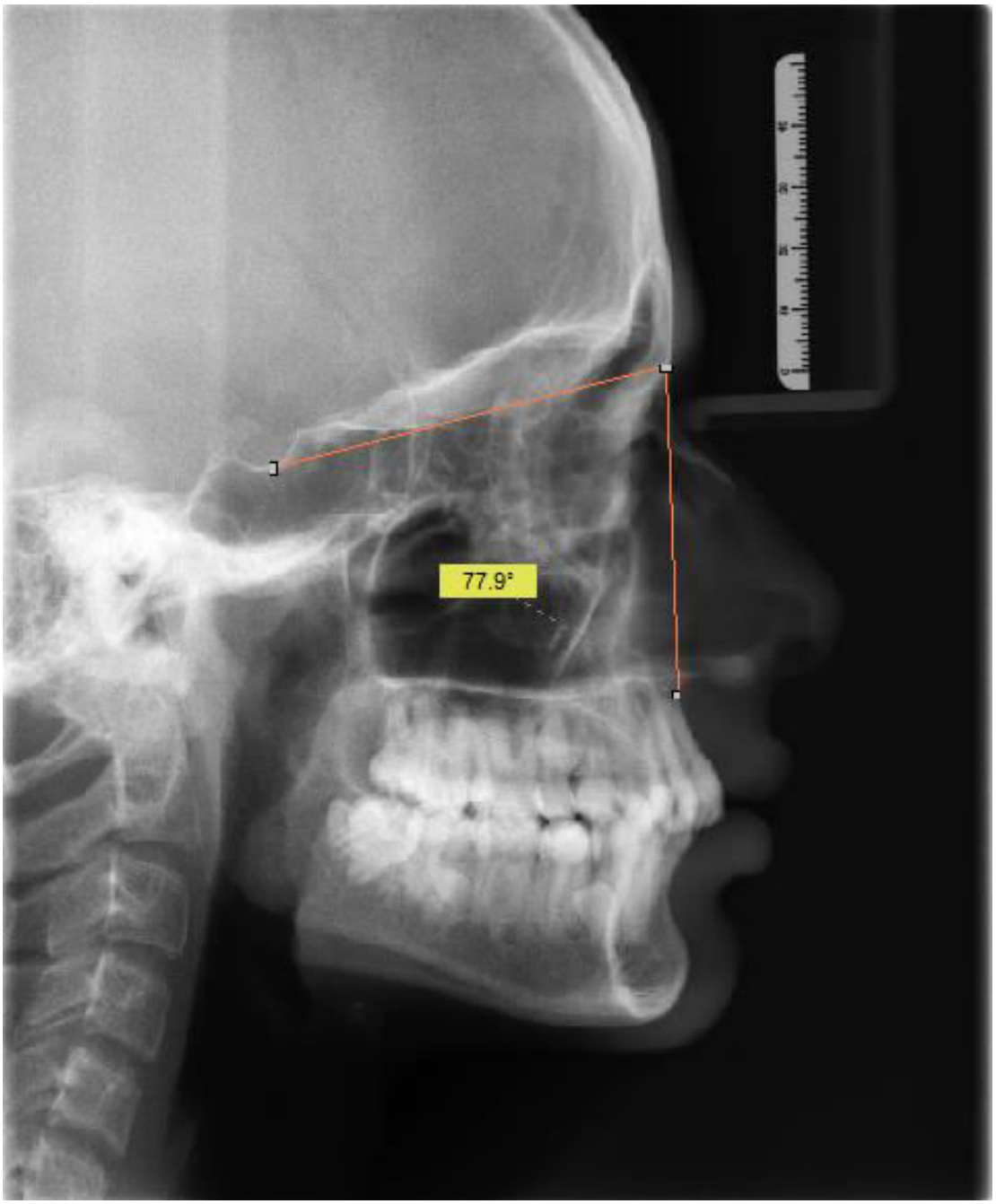


FIGURE 9 – SELLA- NASION- POINT A ANGLE (SNA): This angle indicates the horizontal position of the maxilla relative to the cranial base.

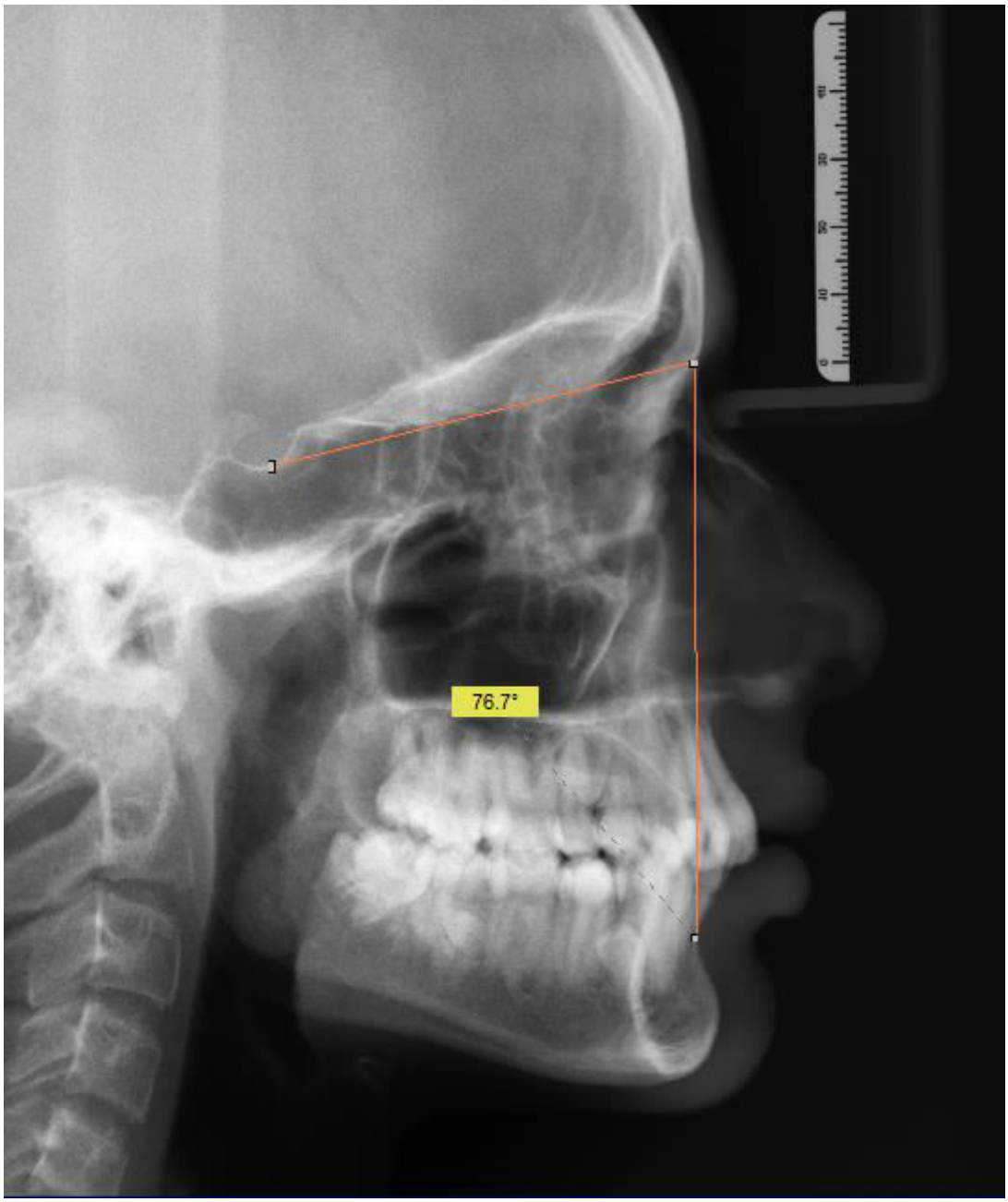


FIGURE 10 – SELLA-NASION- POINT B ANGLE (SNB): This angle expresses the horizontal position of the mandible relative to the cranial base.

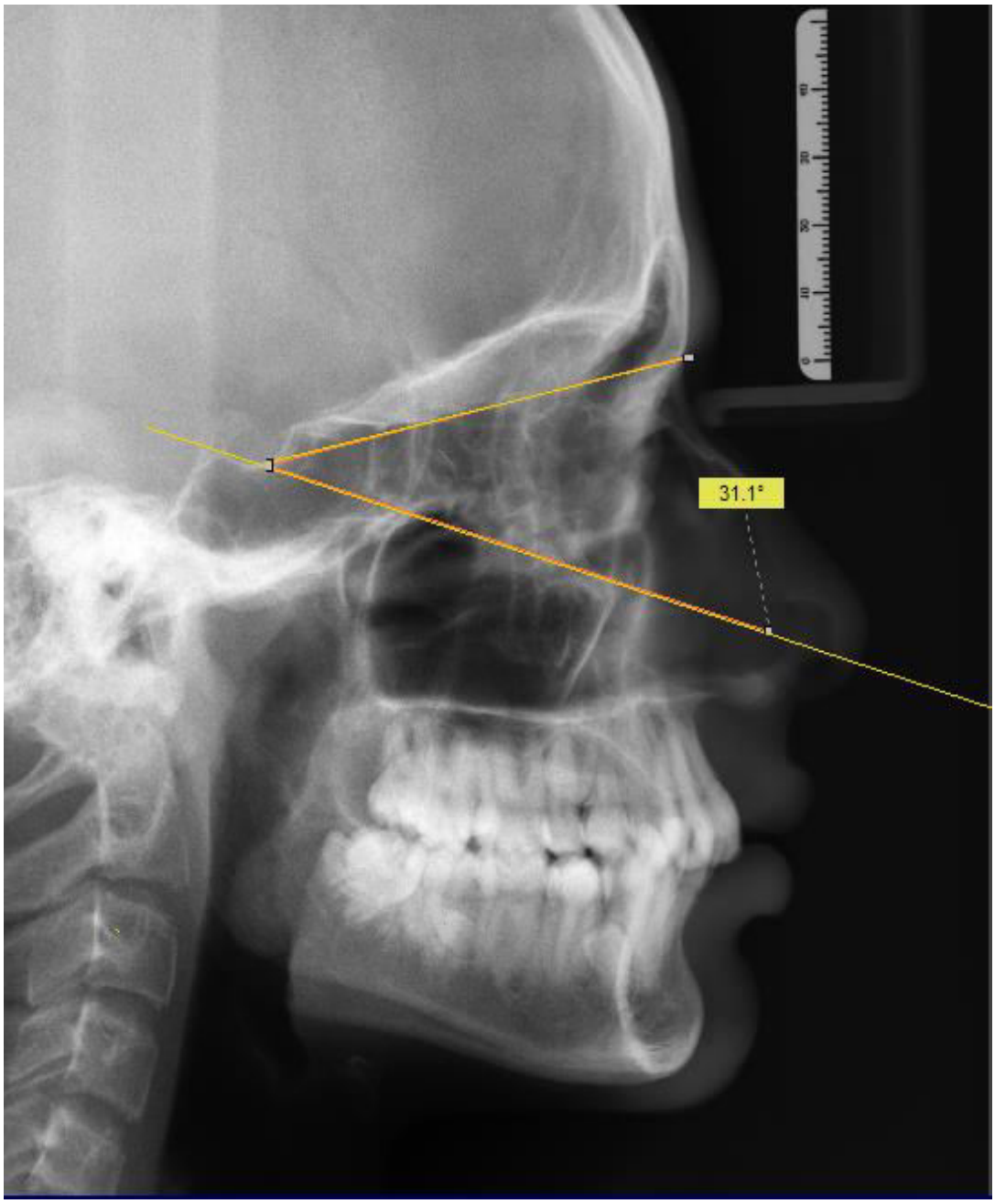


FIGURE 11 – MANDIBULAR PLANE TO SN ANGLE (MP-SN): This angle indicates the growth patterns of an individual.

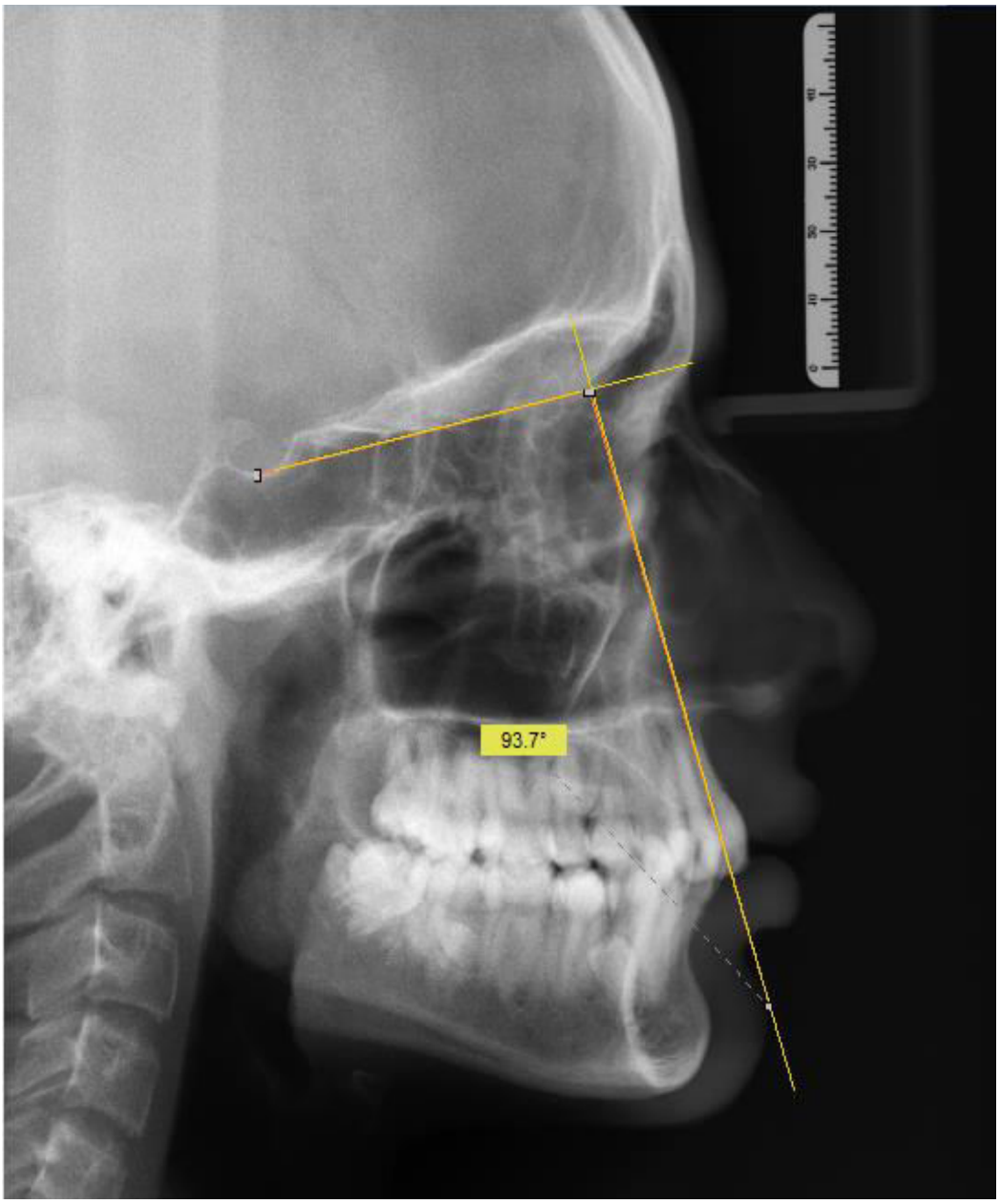


FIGURE 12- UPPER INCISOR TO SN PLANE ANGLE (UI-SN): This angular measurement determines the inclination of the central incisor relative to the anterior cranial base.

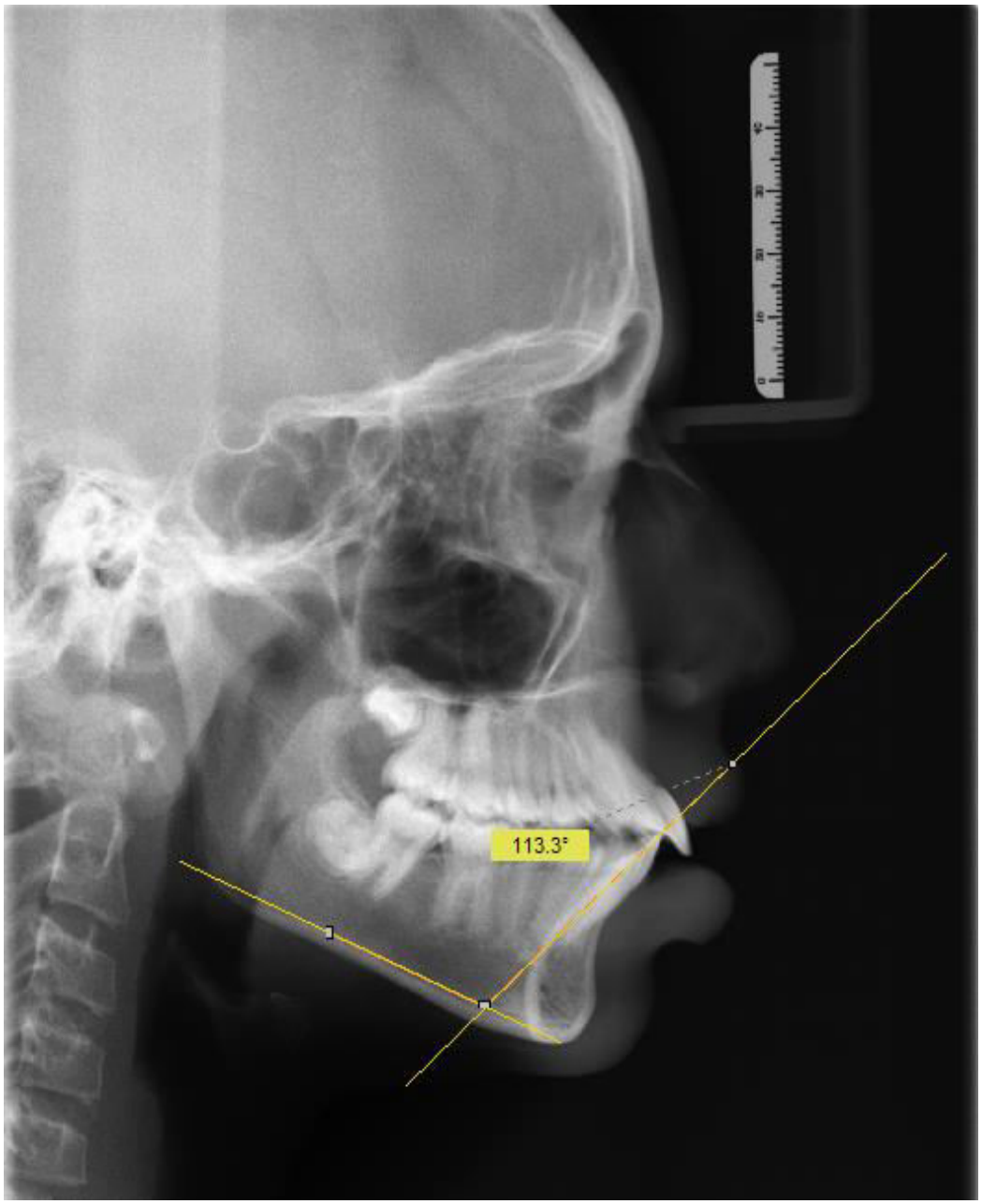


FIGURE 13- LOWER INCISOR TO MANDIBULAR PLANE ANGLE (LI-MP): It defines the axial inclination between the mandibular incisor and the inferior border of the mandible.

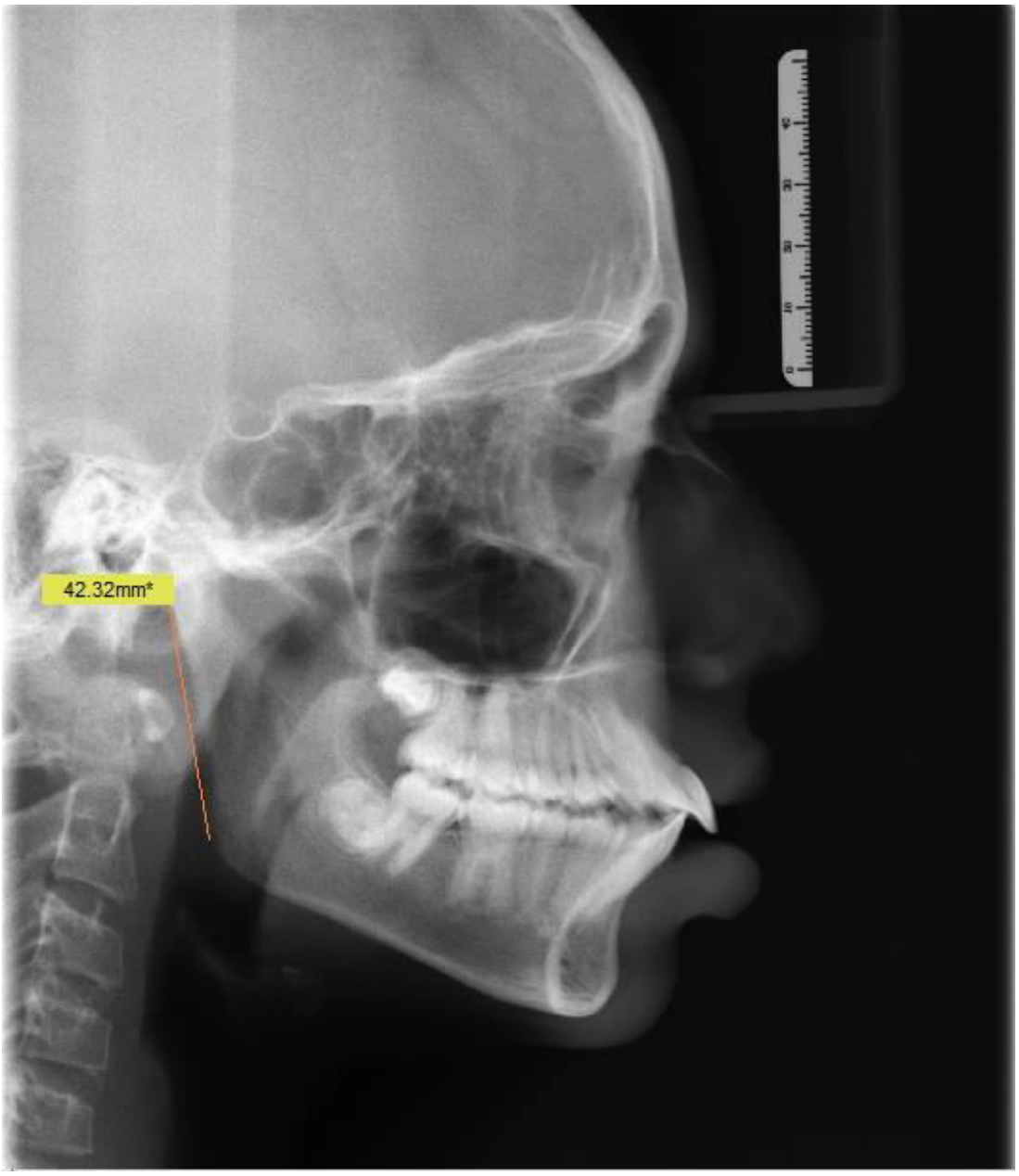


FIGURE 14 – GONION ARTICULARE LINE LENGTH (Go-Ar): Represents the linear distance between articulare and gonion, which indicates the ramal height.

Statistical Analysis

STATISTICAL ANALYSIS

The data obtained from the study was entered in Microsoft Excel and statistical analysis was done. The data was analysed using Statistical Package for Social Sciences(SPSS) software version 16.0(Windows version 17.0 SPSS Inc.,Chicago,IL,USA).The level of significance (α) was fixed at 5% ($p \leq 0.05$). Statistical analysis was done using the t-test and ANOVA.

t TEST :

Statistical analysis was done using t –test. A *t*-test is most commonly applied when the test statistics would follow a normal distribution if the value of a scaling term in the test statistic were known.

Analysis of variance (**ANOVA**)

ANOVA provides a statistical test of whether the population means of several groups are equal, and therefore generalizes the *t*-test to more than two groups. ANOVA is useful for comparing (testing) three or more group means for statistical significance.

Results

RESULTS

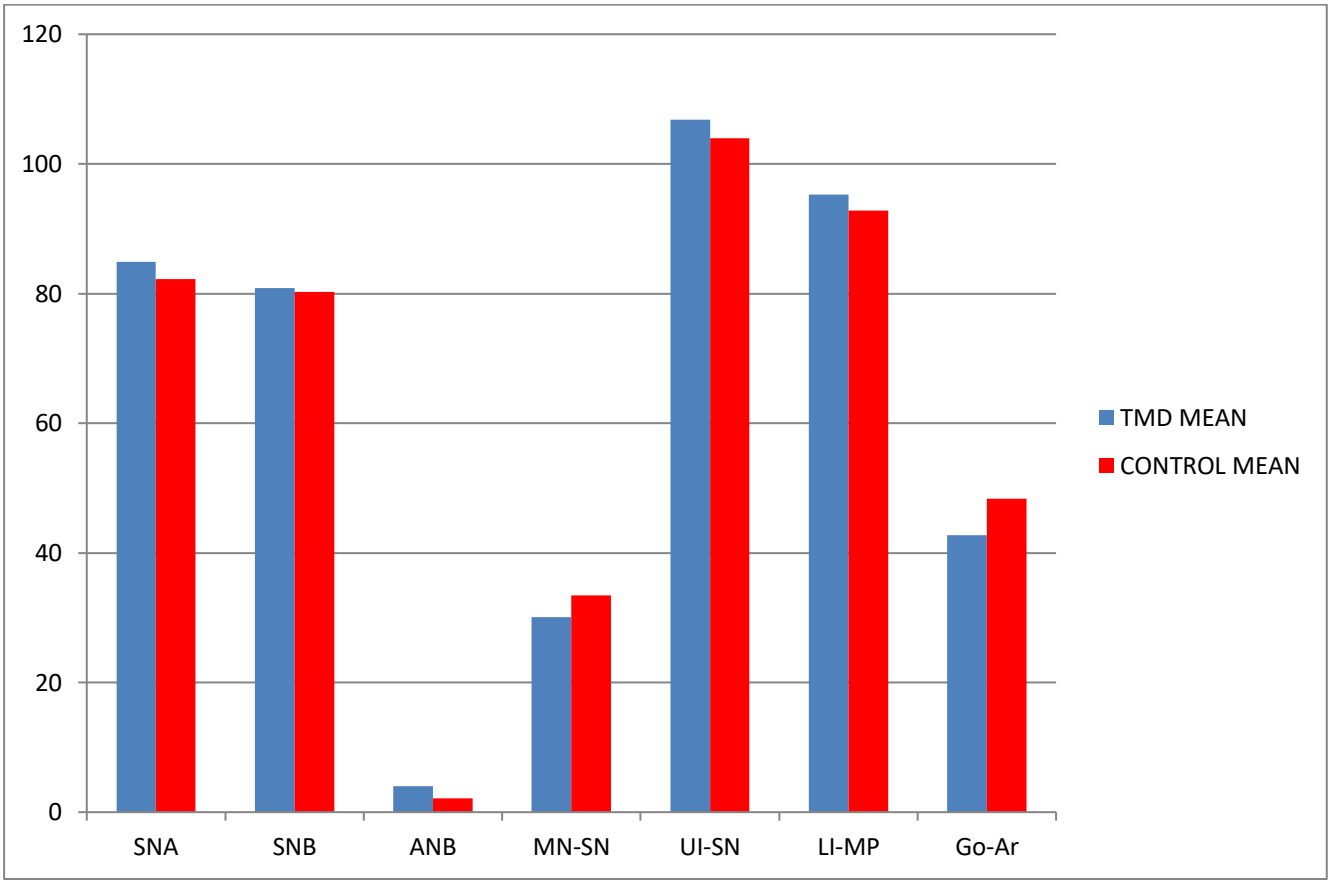
TABLE 4: SHOWING COMPARISON OF THE ANGUALTIONS BETWEEN PATIENTS WITH TEMPOROMANDIBULAR DISORDERS AND CONTROL PATIENTS

ANGLE	TMD MEAN	TMD STANDARD DEVIATION	CONTROL MEAN	CONTROL STANDARD DEVIATION	P VALUE
SNA	84.85	4.01995	82.28	1.99663	.036
SNB	80.82	3.79664	80.25	2.00000	.000
ANB	4.04	4.83718	2.18	2.53071	.000
MN-SN	30.12	4.14097	33.45	1.59519	.000
UI-SN	106.82	3.98970	103.93	1.66862	.001
LI-MP	95.24	4.10514	92.81	1.98060	.052
Go-Ar	42.77	2.61504	48.33	2.09679	.160

- The mean SNA angle for patients with temporomandibular disorders (84.85± 4.01995) is greater than in control patients (82.28 ±1.99663) indicating that the patients with TMD will have a prognathic maxilla. The SNB angle is relatively similar for both TMD patients (80.82±3.79664) and control patients (80.25±2.00000). ANB angle is shown to be increased in patients with TMD (4.04±4.83718) indicating a general class II skeletal pattern. The mandibular plane with cranial base angle (MN-SN) is less in TMD patients indicating a horizontal growth pattern when evaluated in

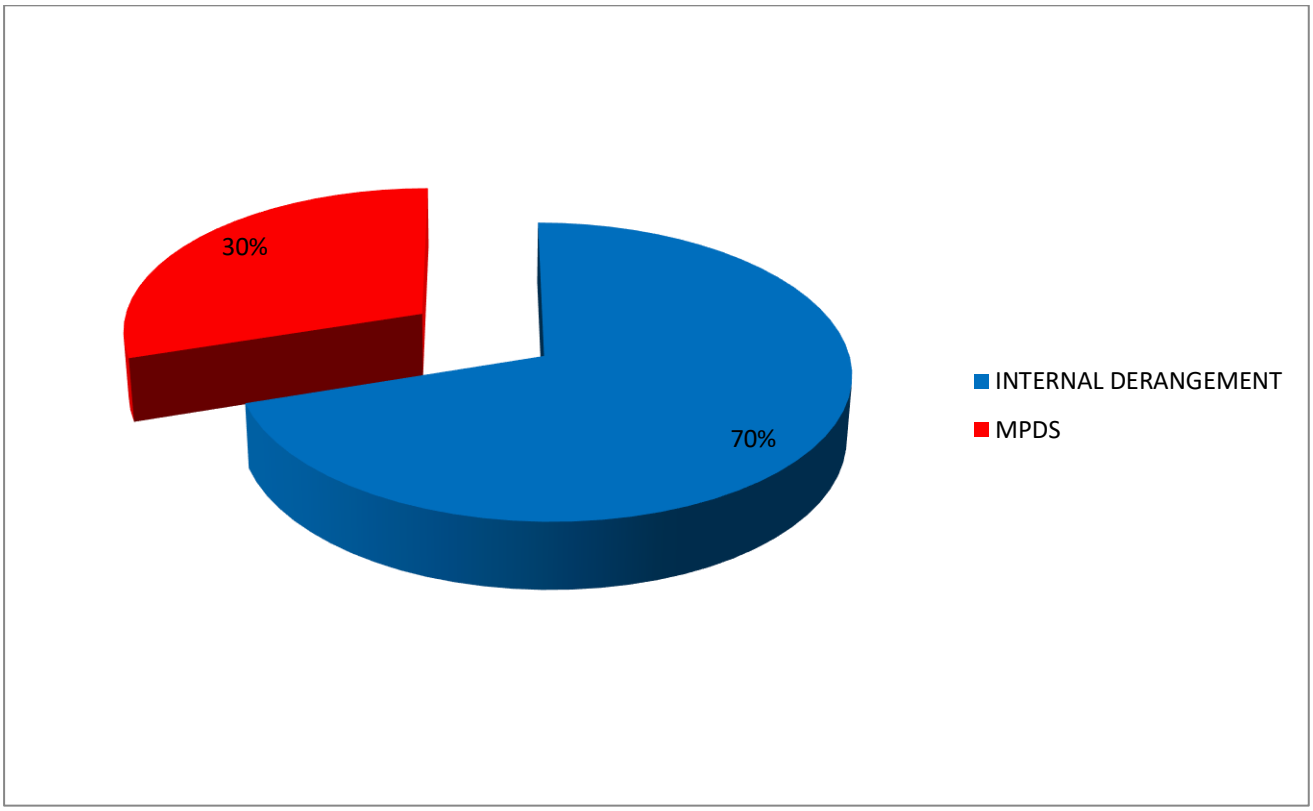
relation with the control group. The UI-SN angle and LI-MP angle is increased when compared to the control patients, which implies proclined maxillary and mandibular incisors in TMD patients. The gonion-articulare line length (Go-Ar) is decreased in patients with TMD indicating less ramal length, where as the control patients had an increased height of the ramus.

CHART 1: SHOWING COMPARISON OF THE ANGUALTIONS BETWEEN PATIENTS WITH TEMPOROMANDIBULAR DISORDERS AND CONTROL PATIENTS WITH STANDARD DEVIATION



The bar diagram depicts the angulation for patients with tempromandibular disorders shown in blue and angulation for the control patients shown in red.

CHART 2: PATIENTS EXHIBITING MYOFASCIAL PAIN DYSFUNCTION SYNDROME AND INTERNAL DERANGEMENT



Among the 40 patients examined with temporomandibular disorders 70% were diagnosed as having internal derangement while 30% had myofascial pain dysfunction syndrome.

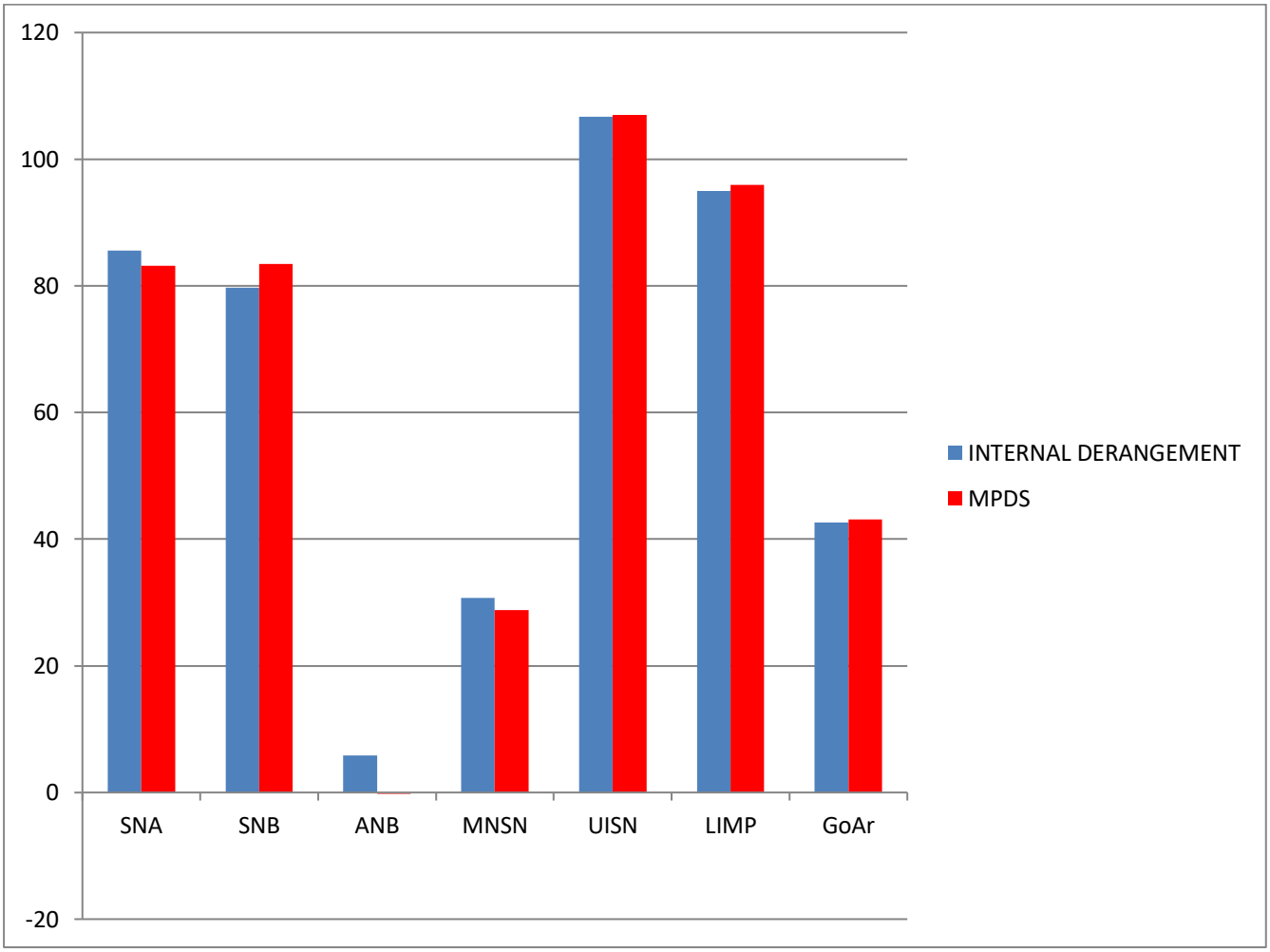
TABLE 5 : SHOWING COMPARISON OF THE MEAN ANGUALTIONS BETWEEN PATIENTS WITH MYOFASCIAL PAIN DYSFUNCTION SYNDROME AND INTERNAL DERRANGEMENT WITH STANDARD DEVIATION .

ANGLE	MEAN VALUE FOR INTERNAL DERANGEMENT	STANDARD DEVIATION FOR INTERNAL DERANGEMENT	MEAN VALUE FOR MPDS	STANDARD DEVIATION FOR MPDS
SNA	85.56	2.87768	83.21	5.72323
SNB	79.68	3.41088	83.48	3.40057
ANB	5.88	3.01633	-.25	5.65485
MN-SN	30.70	4.37129	28.76	3.31894
UI-SN	106.73	4.26624	107.01	3.42091
LI-MP	94.95	4.38334	95.91	3.44765
Go-Ar	42.62	2.85454	43.13	2.01274

- SNA angle was increased in patients with internal derangement (85.56±2.87768) compared to those with myofascial pain dysfunction syndrome (83.21± 5.72323) indicating a prognathic maxilla. SNB angle was decreased in patients with internal derangement (79.68±3.41088) indicating a retrognathic mandible.

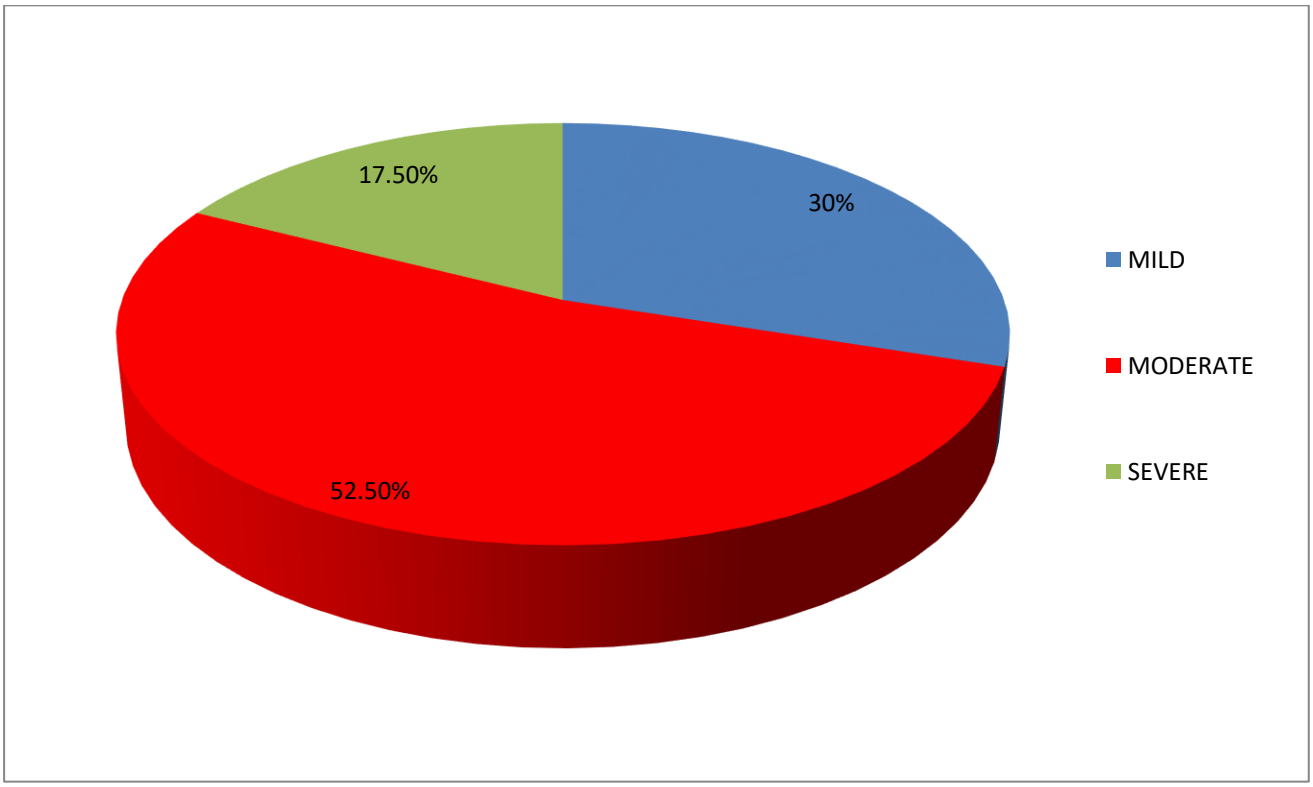
The ANB angle was markedly reduced in patients with MPDS when compared to patients with internal derangement. This indicates a tendency for class II skeletal pattern in internal derangement and class III skeletal pattern in patients with MPDS. The MN-SN angle reveals a horizontal growth pattern for both internal derangement and MPDS. The UI-SN angle, LI-MP angle and and Go-Ar angle also reveals similar results between the two groups.

CHART 3: SHOWING THE COMPARISON OF ANGULATION FOR PATIENTS EXHIBITING MYOFASCIAL PAIN DYSFUNCTION SYNDROME AND INTERNAL DERANGEMENT.



The bar diagram shows persons with internal derangement in blue and myofascial pain dysfunction syndrome in red.

CHART 4: SHOWING PERCENTAGE OF PATIENTS WITH TEMPOROMANDIBULAR DISORDERS CLASSIFIED ACCORDING TO GRADE



Patients were graded based on the symptoms expressed which resulted in, 30% with mild temporomandibular disorders, 52.5% with moderate temporomandibular disorders and 17.5% with severe temporomandibular disorders.

TABLE 6: SHOWING THE COMPARISON OF THE MEAN ANGULATION BETWEEN DIFFERENT GRADES OF TMD WITH STANDARD DEVIATION

ANGLE	MEAN FOR MILD TMD	STANDARD DEVIATION FOR MILD TMD	MEAN FOR MODERATE TMD	STANDARD DEVIATION FOR MODERATE TMD	MEAN FOR SEVERE TMD	STANDARD DEVIATION FOR SEVERE TMD
SNA	84.87	2.36156	86.61	3.66596	79.54	2.50257
SNB	79.94	2.83948	80.20	4.27791	84.17	1.39250
ANB	4.93	2.47685	6.42	2.91370	-4.63	1.87057
MN-SN	30.80	4.29185	30.41	4.30050	28.06	3.13840
UI-SN	105.64	6.21032	107.70	2.44673	106.19	2.62198
LI-MP	95.68	6.10973	94.55	3.07516	96.54	2.35149
Go-Ar	43.36	2.47109	42.39	2.84505	42.93	2.24404

- On comparing the angulations between mild, moderate and severe grades of temporomandibular disorders classified based on the scores obtained from the symptoms expressed by the patients, a striking difference was noted in the ANB angle in patients with severe temporomandibular disorders who expressed a negative angulation. This indicates a Class III skeletal jaw relationship, deficient maxilla or prognathic mandible in patients with severe temporomandibular disorders when compared to patients with mild and moderate TMD. The difference was due to decreased SNA angle and increased SNB angle in patients with severe TMD when compared to the other grades.

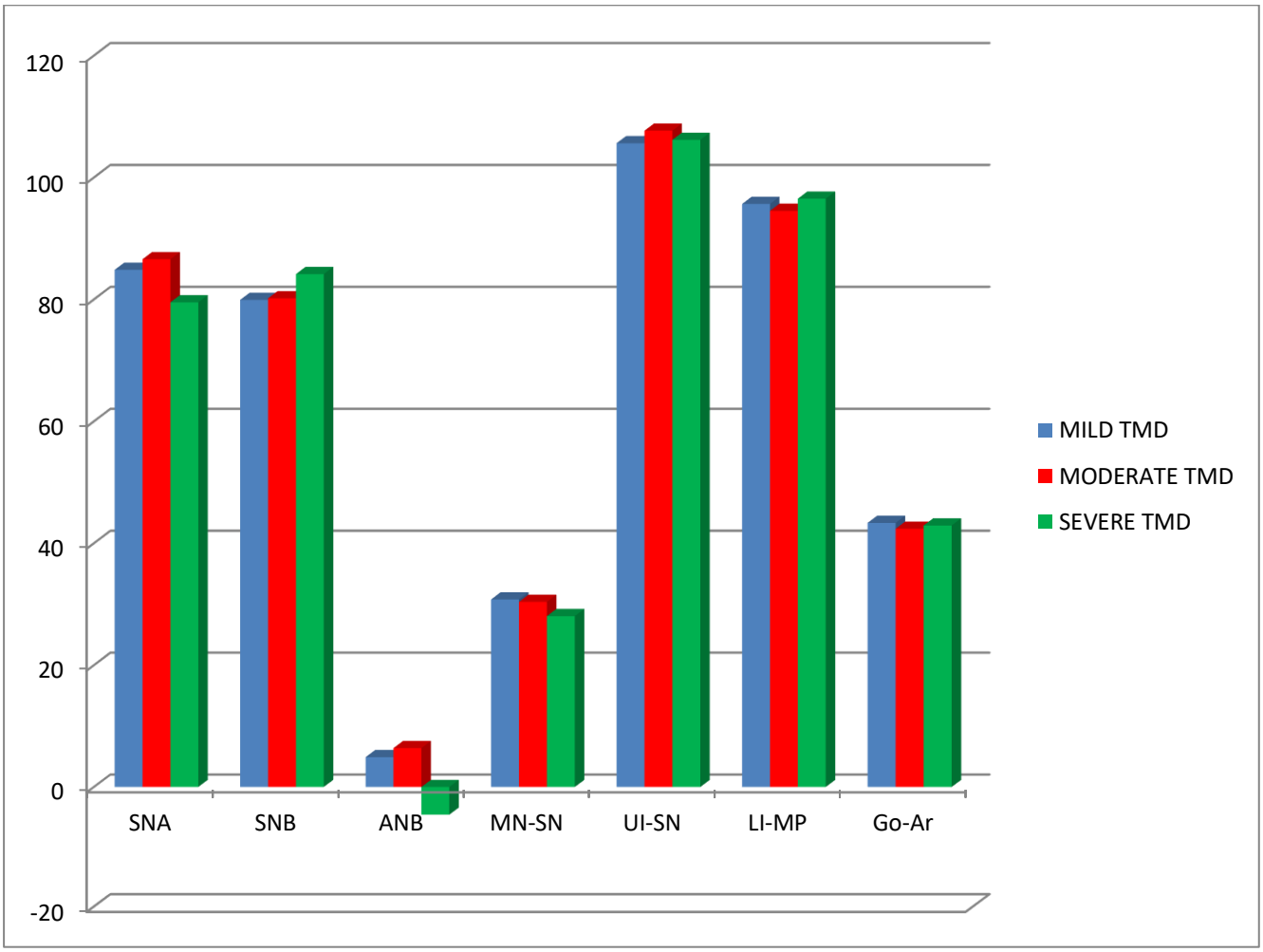
The MN-SN angle was reduced in patients with severe TMD (28.06± 3.13840), but the values for all the grades indicated a horizontal growth pattern. The UI-SN, LI-MP and Go-Ar are all similar for the three grades indicating proclined maxilla and mandible.

TABLE 7 : TABLE SHOWING THE P-VALUE FOR THE VARIOUS GRADES OF TMD

ANGLE	P- VALUE
SNA	.000
SNB	.009
ANB	.000
MN-SN	.000
UI-SN	.000
LI-MP	.005
Go-Ar	.000

- On comparing the angulations between mild, moderate and severe grades of temporomandibular disorders classified based on the scores obtained from the symptoms expressed by the patients, the results had significant p value for all the angles.

CHART 5: SHOWING THE COMPARISON OF THE MEAN ANGULATION BETWEEN DIFFERENT GRADES OF TMD .



The bar diagram depicts the angulation for patients with mild TMD in blue color, angulation for patients with moderate TMD in red color and angulation for patients with severe TMD in green color.

Discussion

DISCUSSION

The TMJ is classified as a compound joint, which performs important roles in dental occlusion and the neuromuscular system.[68] Temporomandibular disorders have complex and controversial etiologies.

Factors that increase the risk of temporomandibular disorders are called predisposing factors, factors that cause the onset of temporomandibular disorders are called initiating or precipitating factors, and factors that interfere with healing or enhance the progression of temporomandibular disorders are called perpetuating factors.

Predisposing factors for temporomandibular disorders can be systemic that affects the entire body or a particular body system, psychosocial that is the interaction of psychological and social variables, physiologic such as neuromuscular , cellular and metabolic processes and structural which includes dental occlusion, musculoskeletal, articular or developmental anomalies. [69]

Precipitating factors often involve trauma or overuse. Repetitive activities with the jaw in an abnormal or sustained posture or under abnormal load, due to activities such as playing a wind instrument or violin, or sleep posture can trigger a painful TMD episode. Perpetuating factors often include parafunctional habits, systemic disease, occlusal factors, or psychological distress.[70]

Patients tend to indicate different signs and symptoms such as pain during mouth opening, chewing, crepitation, clicking in the area of temporomandibular joint or ear, limited mandibular opening, morning stagnation and sleep disorders .[71] Epidemiological studies have shown that

approximately 75% of adult population has at least one symptom related to TMD dysfunction and 30% has two or more symptoms.[72]

In this study, headache, ear ache, hearing of clicking sound, muscular pain while chewing, and being a tensed person were the common symptoms expressed by the patients. On clinical examination, clicking of the joint, jaw deviation and tenderness of masseter and lateral pterygoid muscles were the most common signs observed. **Vaibhav Motghare et al (2015)** conducted a study on 240 adolescents studying in schools of Greater Noida. In their study, Headache, Neck pain and clicking sounds were most frequent reported symptoms of TMD. They also stated significant association between gender and sign and symptoms of TMD.[3]

In most cases, TMJ disk displacement remains asymptomatic depending on the patient's tolerance level and adaptive capacity. [73] Orthodontic tooth movement produce overt symptoms of TMD in some patients. Lateral cephalogram has long been a well-recognized orthodontic diagnostic aid and is taken regularly in routine orthodontic treatment. Certain lateral cephalometric variables can be identified to be of diagnostic value and can point to potential patients with temporomandibular disorders.[74]

This study included a total of 80 patients, which consisted of 40 patients who had temporomandbular disorders and 40 age and gender matched subjects who were taken as controls . This study population was more than in the study done by **Asim Mustafa Khan et al (2014)**, which included thirty-eight patients with temporomandibular disorders and thirty-two asymptomatic individuals.[75]

The lateral cephalograms stored in the dicom software was analysed digitally using Steiner's and Rakosi's analysis and interpreted using the already established standard values. The use of computers in research and treatment planning is expected to avoid errors and make it less time consuming with effective evaluation and high reproducibility.

In this study, the analysis of cephalometric angles between patients with temporomandibular disorders and control patients revealed all the angles were significant with P value being ≤ 0.05 except for the distance between gonion and articulare. It was revealed in our study, that patients with temporomandibular disorders will tend to exhibit a prognathic maxilla and a general class II skeletal pattern. They will usually have proclined incisors and a horizontal growth pattern. In a similar study conducted by **OC Almăşan et al (2013),** it was demonstrated that angle's Class II and III malocclusions, and large overjet have been associated with signs and symptoms of TMD.[66] A study done by **Thilander *et al*. (2002)** demonstrated that TMD is significantly associated with posterior crossbite, anterior open bite, Angle's Class III malocclusion, and extreme maxillary overjet.[76]

Ahn et al. (2006) , in a study on 134 women, implied that subjects with decreased forward growth of mandible and reduced ramal height were predisposed to temporomandibular disorders[64] while **Chung-Ju et al (2006)** found that subjects with a TMD had a greater ramus height and more lingual tilting of the maxillary incisors.[18]

To facilitate the conduction of clinical research, a classification scheme called the Research Diagnostic Criteria for Temporomandibular Disorders

(RDC/TMD) which diagnoses the presence of TMD has been used since 1992. The RDC/TMD is a tool for clinical diagnostic criteria which is measurable and reproducible and aims at identifying subgroups of patients with TMD. The RDC/TMD classifies the most temporomandibular disorders into three subgroups: Disorders of the masticatory muscles (myofascial pain), TMJ internal derangement (disk displacement), and degenerative diseases of the TMJ (arthralgia, arthritis and osteoarthritis).

This study consisted of 70% of patients with internal derangement and 30% with myofascial pain dysfunction syndrome. On comparing the mean angualtions between patients with myofascial pain dysfunction syndrome and internal derangement, a predisposition for class II skeletal pattern in internal derangement and class III skeletal pattern in patients with MPDS was noted. In a study by **Byun ES et al (2005)**, he illustrated internal derangement of the temporomandibular joint was much more prevalent in subjects with a more posteriorly rotated mandibular ramus and a skeletal Class II pattern. He also stated that these patterns were more severe as the internal derangement progressed to disk displacement without reduction.[77]

In our study, the patients with temporomandibular disorders were interviewed according to Fonseca's Anamnestic Questionnaire. According to **Bevilaqua-Grossi et al (2006)**, Fonseca questionnaire is a simple questionnaire, without pretension to diagnose TMD, it will aid in observing the symptoms reported by the patients.[78] The frequency of symptoms and severity is assessed, aiming to identify those patients that require treatment for TMD. Fonseca Anamnestic Index has been used by many researchers and it

demonstrates excellent reliability as proven by studies done to analyse its accuracy and reliability such as the one conducted by **Pires PF et al** in 2018.[79]

Fonseca Anamnestic questionnaire consists of 10 questions. The response to the questions were scored by assigning marks and graded as mild, moderate and severe. In this study, 30% had mild temporomandibular disorders, 52.5% had moderate temporomandibular disorders and 17.5% had severe temporomandibular disorders. On comparing the angulations between grades of temporomandibular disorders, a Class III skeletal jaw relationship with a deficient maxilla or prognathic mandible was noted in patients with severe temporomandibular disorders, when compared to patients with mild and moderate TMD.

In a related study done by **Nomura K et al (2007),** on 218 dental students from a Brazilian public university 35.78% had mild TMD, 11.93% had moderate , 5.5% had severe TMD.[80] Another study by **Habib SR et al (2015)** on 400 participants revealed 53.2% of participants were classified as not having TMD, while (36.1%) had mild TMD, 9.6% had moderate TMD , and 1.1% had severe TMD.[81] Our study proves to be unique in its capability to compare the cephalometric characteristics of patients with temporomandibular disorders according to the severity of the disorder.

The dentist's awareness of the early signs and symptoms of temporomandibular joint disorders is crucial, as disease of the temporomandibular joint is commonly undiagnosed. The management of Temporomandibular Disorders is usually noninvasive, especially if the disorder is detected in the early stages.

Cephalometric radiographs are standardised radiographs which are cost effective and regularly taken for patients undergoing orthodontic treatment. Identification of the characteristics exhibited in the radiographs that are more specific for patients with temporomandibular disorders, can be a fundamental factor for early diagnosis.

Summary and Conclusion

SUMMARY:

This study was undertaken in order to evaluate the correlation between cephalometric characteristics in patients with temporomandibular joint disorders compared to a control group and determine the variation in angulation. Lateral cephalographs were analyzed digitally to compare the difference between the control group and TMD patients and evaluated via Steiner's analysis and Rakosi's analysis. It was revealed on comparison of the angualtions between patients with temporomandibular disorders and control patients, that patients with temporomandibular disorders will tend to exhibit a prognathic maxilla and a general class II skeletal pattern. They will usually have proclined incisors and a horizontal growth pattern. On comparison of the mean angualtions between patients with myofascial pain dysfunction syndrome and internal derangement a tendency for class II skeletal pattern in internal derangement and class III skeletal pattern in patients with MPDS was noted. Persons with internal derangement presented frequently with a prognathic maxilla. On comparison of the mean angulation between different grades of TMD, a Class III skeletal jaw relationship, deficient maxilla or prognathic mandible were seen in patients with severe temporomandibular disorders when compared to patients with mild and moderate TMD.

CONCLUSION:

The patients reporting for routine cephalometric radiographs are usually teenagers and young adults undergoing orthodontic treatment. The recognition of cephalometric characteristics prone to cause temporomandibular disorders, can lead to further evaluation for signs and symptoms of temporomandibular disorders and it can in turn facilitate early diagnosis. This will help improve the course of the treatment and the quality of life of young adults.

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Annexures

ANNEXURE I

QUESTIONNAIRE

EVALUATION OF CORRELATION BETWEEN CEPHALOMETRIC CHARACTERISTICS AND TEMPOROMANDIBULAR JOINT DISORDERS: A RADIOGRAPHIC CROSS-SECTIONAL STUDY

GENDER: **MALE:** ☐ **FEMALE:** ☐

AGE: **.....**

	YES	NO	SOMETIMES
1. Is it hard for you to open your mouth?	☐	☐	☐
2. Is it hard for you to move your mandible from side to side?	☐	☐	☐
3. Do you get tired /muscular pain while chewing?	☐	☐	☐
4. Do you have frequent headaches?	☐	☐	☐
5. Do you have pain on the nape or stiff neck?	☐	☐	☐
6. Do you have earaches or pain in craniomandibular joints?	☐	☐	☐
7. Have you noticed any TMJ clicking while chewing or when you open your mouth?	☐	☐	☐
8. Do you clench or grind your teeth ?	☐	☐	☐
9. Do you feel your teeth do not articulate well?	☐	☐	☐
10. Do you consider yourself a tense (nervous) person?	☐	☐	☐

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ANNEXURE II

INFORMED CONSENT FORM

KSR INSTITUTE OF DENTAL SCIENCE & RESEARCH

EVALUATION OF CORRELATION BETWEEN CEPHALOMETRIC CHARACTERISTICS AND TEMPOROMANDIBULAR JOINT DISORDERS: A RADIOGRAPHICCROSS-SECTIONAL STUDY.

Name: **Age:** **Sex:** **OP no:** **Date:**

Address:

I_____ hereby declare that I clearly understood the procedures of the study. Also, I declare that I give permission to the above mentioned individual/organization/hospital to do the procedures required.

Signature _____ Date _____

I have explained the above and answered all questions asked by the participant.

Signature _____ Date _____

ANEXURE III

ஒப்புகை வாக்குமூலம்

..... ஆகிய நான் மேற்கூறிய ஆராய்ச்சி படிப்பின் வழிமுறைகளைத் தெளிவாகப் புரிந்து கொண்டேன். மேலும் நான் இந்த ஆராய்ச்சிப் படிப்புக்கான வழிமுறைகளை மேற்கொள்வதற்கும், அதன் பரிசோதனை முடிவுகளை தெரிந்து கொள்ளவும் முழுமையாக அனுமதிக்கிறேன்.

.....

நோயாளியின் கையொப்பம் தேதி.....

நான் மேற்கூறிய ஆராய்ச்சிப் படிப்பிற்கான விதிமுறைகள் மற்றும் அது குறித்த நோயாளியின் சந்தேகங்களையும் தெளிவாக விளக்கியுள்ளேன்.

.....

மருத்துவரின் கையொப்பம் தேதி.....

ANEXURE IV

INSTITUTIONAL ETHICAL COMMITTEE

KSR INSTITUTE OF DENTAL SCIENCE & RESEARCH
KSR Kalvi Nagar, Tiruchengode-637 215, Tamilnadu.
Phone : 04288-274981, Fax : 04288-274761,
email : ksrdentalcollege@yahoo.com

Ref.: 156/KSRIDSR/EC/2016 **Date : 19.12.2016**

To

Dr.Silpa Ramachandran,
Postgraduate Student,
Dept. of Oral Medicine & Radiology,
KSR Institute of Dental Science & Research,

*****

Your dissertational study titled "EVALUATION OF CORRELATION BETWEEN CEPHALOMETRIC CHARACTERISTICS AND TEMPOROMANDIBULAR JOINT DISORDERS – A RADIOGRAPHIC CROSS SECTIONAL STUDY" presented before the ethical committee on 16th Dec. 2016 has been discussed by the committee members and has been approved.

You are requested to adhere to the ICMR guidelines on Biomedical Research and follow good clinical practice. You are requested to inform the progress of work from time to time and submit a final report on the completion of study.

Signature of Member Secretary
(Dr.G.S.Kumar)